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INFLUENZA IN PIGS

In this number of The Veterinary Journal is published an abstract of a discussion on "swine influenza in the British Isles" which took place at a meeting of the Section of Comparative Medicine of the Royal Society of Medicine on April 23, 1941, and which was published in full in the July number of the Proceedings of the Society. While the subject is still in the early stages of investigation it seems to be proved that there exists in England an influenza of young pigs with a filterable virus as its cause. It has been known for some time that an influenza-like disease of young pigs existed in Northern Ireland (Lamont, H. G. (1938) : *Vet. Rec. 50,* 1377) and the existence of somewhat similar diseases are known in America and on the Continent of Europe. It may well be that all these influenza-like diseases are due to the same causal agent or that the strains of virus associated with the diseases may vary in some antigenic characters : further research with the viruses will determine their similarity or relationship. Their resemblance to the virus or viruses responsible for outbreaks of human influenza is also marked and again research will determine their relationship.

The disease in England is of much importance to the pig keeper, for although the death rate may be small, the unthriftiness following outbreaks means economic loss. Further, the recovery of the virus from the lungs of pigs at an age when they are being slaughtered for food opens up the question of "carriers" of the infection in herds. While infected pigs may recover and, though having definite lung lesions, may thrive and reach marketable quality,

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they may act as transmitters of the infection to susceptible young pigs, given the conditions conducive to the development of the disease.

Several interesting points are brought out in the discussion. The association of the virus with secondary invading organisms in the lungs is of some importance. Whether secondary invaders play an essential part in the causation of the influenza-like diseases does not seem yet to be established. There is evidence from other diseases that the rôle of micro-organisms associated with a virus is purely in a secondary capacity: they probably give rise to the actual lesions found in the disease. This seems to be true of canine distemper. While in America the association of *Hæmophilus influenzæ* with the virus in swine influenza is stressed by some workers, it would appear from the discussion that in this country the disease can be set up in pigs by filtrates of the lungs of infected pigs and further that the micro-organismal flora of the lungs is by no means constant. These findings would tend to show that the micro-organisms may not be an essential part of the cause of the disease and probably act as secondary invaders giving rise to the lesions in the lungs.

The transmission of the disease by the migrating larval forms of nematodes in the lungs has been put forward in some quarters. No evidence of such an occurrence was given in the discussion. Further research is required. We look forward to further work on the subject of influenza of the pig, when the many points still awaiting solution will doubtless receive attention.

DIAPHRAGMATIC HERNIA IN A CAT

THE following seems of sufficient interest to merit recording.

A healthy, all black, male cat weighing seven pounds was one of a series being used in a study of post-lobectomy collapse of the lung. It was anæsthetised by intraperitoneal nembutal after which an intratracheal catheter was passed and five c.c. of iodized oil injected. The bronchogram after X-ray was unsatisfactory and so two days later the animal was again anæsthetised but died some twenty minutes later without any further procedure.

Post-mortem examination showed the anterior part of the diaphragm on both sides of the body was missing. The whole of the liver and the spleen was in the right chest while the lower part of the small bowel and the proximal part of the colon were in the left chest, causing collapse of the lower lobes of the lungs.

There was marked venous congestion of all the organs and dilatation of the right side of the heart. Undoubtedly the unsatisfactory X-ray was due to the distortion of the thoracic viscera by the herniated abdominal contents.

J. P. CHESTERMAN.

General Articles

A BACTERIOLOGICAL EXAMINATION OF BOVINE TONSILS AND VAGINAS

The Possible Relationship of the Findings to Mastitis and Pneumonia

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THE circumstances under which all forms of bovine mastitis arise are somewhat obscure: this disease is not a bacteriological entity and its control depends on a full understanding of its bacteriology and pathogenesis. Streptococci and staphylococci are recognised as common causes but owing to its prevalence greater attention has been paid to the chronic form due to *streptococcus agalactiæ*. Methods of control have been devised and are based on the hypothesis that the only reservoir of this streptococcus is the infected udder. It is recognised that organisms causing certain forms of mastitis may occur in other sites and within recent years evidence has been presented which suggests that the udder is not the only reservoir of *streptococcus agalactiæ*. Minett (1939) has discussed the possibilities of a high incidence of infection with this organism in early life and of what has been called " cultural latency " and he has suggested that calfhood infection might occur. A publication from Australia (*Bull*, 1940) goes even further and indicates that the streptococci and staphylococci found in the udder, including *streptococcus agalactiæ*, may be accepted as environmental bacteria of the dairy cow, and that their activity depends more on the qualities of the host than on those of the bacteria. Forsyth-Stewart (1941) has isolated *streptococcus agalactiæ* from the milk of recently calved heifers in circumstances which preclude the possibility of infection from the diseased udders of other cattle. It was believed that a contribution to the problem might be made by a study of the normal bacteriology of the bovine tonsil and vagina. Therefore an examination has been made in order to ascertain whether or not organisms capable of causing mastitis are present in these sites. Some information is already available on the

* This work was carried out at the Research Institute in Animal Pathology, Royal Veterinary College, London.

bacterial flora of the bovine tonsil. Pilot, Buck and Davis (1936) examined 133 pairs of bovine tonsils and isolated hæmolytic streptococci from 84 per cent. *Bact. coli*, staphylococci and occasionally non-hæmolytic streptococci were also recovered. Hæmolytic streptococci were also found by Davis (1923) in 24 per cent. of seventeen pairs of tonsils whilst the viridans type of streptococcus was almost constantly present. Emmons (1938) isolated *actinomyces bovis* fifteen times from two hundred pairs of bovine tonsils.

The Anatomy and Development of the Tonsil

With the exception of certain rodents, tonsils occur in all mammals, although their form varies. The anatomy of the bovine tonsil has been described by Florentin (1936) and its development by Kingsbury and Rogers (1927). An elliptical opening on the lateral wall of the pharynx gives entry into the sinus tonsillaris and on palpation the tonsil can be felt as a more or less spherical organ. It is approximately 3.5 cms. long and 2.5 cms. wide, it is surrounded by a distinct capsule and a vertical depression on its deep face divides it into anterior and posterior lobes. The tonsil has efferent lymphatics which pass to the cervical and pharyngeal lymphatic glands but it is generally concluded that it has no afferent lymphatics.

Technique of Examination

The heads of ninety-two cattle which had been condemned were obtained from a slaughterhouse and in many of them the submaxillary and retropharyngeal lymph glands showed lesions of tuberculosis or actinobacillosis. The heads of five other adult cattle and three calves were obtained for examination from the pathology department, making a total of one hundred. The ages of the animals varied from about four months to many years; fourteen of the heads from the slaughterhouse showed marked wearing of the incisor teeth, but the majority were young adults.

The bacteriological examination was made within 12-48 hours of slaughter and during the interval between death and examination the heads were kept in the cold room. The tonsils were excised and the deep surface seared. A small portion was removed from each tonsil and the material from each pair was ground up with sand and a little saline in a Griffith tube. Deep ox-blood agar plates were prepared from approximate dilutions of 1/15, 1/300 and 1/6,000 of this mixture. The plates were examined after twenty-four and forty-eight hours' incubation and colonies picked into serum broth and after purification, strains were stored in cooked meat media for future study.

Vaginal swabs were taken from forty dairy cows, care being taken not to contaminate them with fæcal material. Each swab was agitated in about 10 c.c. sterile saline and plates poured from this material and from two dilutions of approximately 1/20 and 1/400.

Identification of Organisms

Streptococci.—The growth and the morphology of the organism were

observed in eighteen-hour serum broth cultures, and the type of hæmolysis was studied by cultivation in deep ox-blood agar plates. The hydrolysis of starch was tested by making surface streaks from broth cultures on to 0.5 per cent. starch agar plates and incubating for two days at 37 deg. C. A watery solution of iodine was then poured over the plate and a clear zone round the streaks showed that hydrolysis of the starch had occurred. Heat resistance and the ability to grow at 45 deg. C. were determined by introducing four drops of an eighteen-hour serum broth culture into each of two tubes of glucose broth. One tube was placed in a water bath at 60 deg. C. for thirty minutes, and then incubated at 37 deg. C. for twenty-four hours. The other tube was placed in a 45 deg. C. water bath for eighteen hours; those tubes in which there was no growth were then incubated for twenty-four hours at 37 deg. C. Fermentation reactions and the hydrolysis of æsculin and of sodium hippurate were read after seven days' incubation. The reaction in litmus milk, 1-15,000 and 1-1,000 methylene blue milk, were also studied and some of the strains were classified by the precipitin technique of Lancefield.

Staphylococci.—Strains which developed a golden pigment and produced a double zone of hæmolysis in ox-blood agar plates were examined for acid and clot production in litmus milk, the fermentation of mannite, and the liquefaction of gelatine; this latter test was made by incubating the test tubes at 37 deg. C. for four days and examining the tubes after cooling.

Corynebacterium pyogenes.—Bacteria which formed hæmolysis in deep blood agar plates, had the characteristic morphology, produced typical changes in litmus milk and liquefied solid serum, were considered to be *C. pyogenes.* Filtrates of cultures grown in cooked meat media for forty-eight hours were tested for their hæmolytic activity in the presence of specific antitoxin (Lovell, 1939).

Results of Examining One Hundred Pairs of Bovine Tonsils

Almost every tonsil contained cheesy and purulent plugs but these were not examined further. The primary blood-agar plates from most pairs of tonsils yielded a profuse growth and colonies for future study were usually picked from the plates inoculated with the highest dilution of material. The predominant organisms were non-hæmolytic gram negative rods and streptococci which gave greenish zones around the colonies. Gram negative rods which grew as colonies with narrow zones of hæmolysis were observed and some of these produced red colonies of the coliform type on McConkey's agar plates.

Eighty-seven strains of streptococci were studied but it was not possible to identify most of them. Those strains which belonged to recognised types are shown in Table I. *Str. agalactiæ* and *str. bovis* were not isolated; Group II mastitis streptococci (Minett, Stableforth and Edwards, 1929; Edwards, 1932) were isolated from five pairs of tonsils and in one case the tonsils were

heavily colonised with this organism. These strains failed to grow at 45 deg. C. and this is in keeping with the findings of Fergusson (1938). Extracts of three of the cultures were tested against Lancefield's group C serum and all gave a positive precipitin reaction. This was expected (Little, 1939b). Group III mastitis streptococci (Edwards, 1932) were isolated from seven pairs of tonsils, and in four cases they appeared to be the predominant organism. Three strains hydrolysed starch slightly; some strains grew at 45 deg. C. and this agrees with the results obtained by Fergusson (1938) and by Slanetz and Naghski (1940). Four further strains were isolated resembling Group III streptococci, except that they failed to hydrolyse sodium hippurate. Three more differed in that they fermented raffinose, and one strain failed to ferment inulin. Similar strains have been isolated by Little (1940) from the udder. Nine strains of hæmolytic streptococci Group C (Lancefield) were isolated; they all fermented sorbite. Seven cultures which were regarded as enterococci were obtained; they grew at 45 deg. C., in 1/1,000 methylene blue milk and resisted 60 deg. C. for half an hour. One strain of *Str. salivarius* Group I (Safford, Sherman and Hodge, 1937) was isolated. *Streptococcus salivarius* Group II of these authors includes strains with the following characteristics: Production of acid or acid and clot in litmus milk, a final pH in glucose broth of 4.9-5.2, no action on sodium hippurate, no growth at 45 deg. C., fermentation of lactose and sucrose, but no action on salicin manitol, raffinose or inulin, production of α hæmolysis in deep blood agar plates. The strains included in this group were isolated from the human throat but it appears that the strains isolated in this study and designated Mastitis Group II streptococci might equally well have been included in *Str. salivarius* Group II. The biochemical characteristics of the remaining strains were very diverse and they could not be grouped together in any satisfactory way.

Corynebacterium pyogenes was isolated on eighteen occasions and was the predominant organism in nine cases. Filtrates of cultures of fourteen strains were tested for their hæmolytic content in the presence of *C. pyogenes* antitoxin. All formed a filtrable hæmolysin, although the amounts produced by the various strains differed considerably.

Three strains of *staphylococcus aureus* were isolated from adult cattle and one from a calf. In every case *C. pyogenes* was isolated from the same pair of tonsils.

Six strains of a hæmolytic gram negative coccobacillus were recovered and the detailed study of five points to its identity with certain Pasteurella-like bacteria which have been described in America and in this country. Jones (1921) divided *B. bovisepticus* into three groups and his Group I is similar to strains described in Great Britain by Tweed and Eddington (1930), Lovell and Hughes (1935) and Montgomerie *et al.* (1938). This organism is associated with pneumonia in calves and sheep and has been referred to as a

TABLE I

Characteristics of Streptococci isolated from Tonsil and Vagina

Type	Number	Methylene Blue 1: 15,000	Litmus Milk	Final pH in glucose broth	Æsculin	Inulin	Lactose	Mannite	Raffinose	Starch hydrolysis	Sod. hippurate	Growth at 45 deg. C.	Heat resistance at 60 deg. C. 30 mins.
Group II Mastitis	6	Sl. R or sl. R soft C	A or A soft C sl. R	4.9 to 5.2	—	—	A	—	—	—	—	—	—
Group III Mastitis	8	R or R soft C	A soft C sl. R	4.5 to 4.9	+	A	A	A	—	5 — 3 +	+	3 — 5 +	—
Group C (Lancefield)	9	Sl. R	A sl. R or A sl. R soft C	4.5 to 4.9	+	—	A	—	—	+++	2 ± 7 —	—	—
Enterococcus	6	R C or sl. R	A R or A R C	4.2 to 4.6	+	—	A	3 A 3 —	3 A 3 —	—	2 + 4 —	+	+
Strept. acidominimus	15	— or sl. R	— or sl. A & R	5.4 to 6.2	9 + 6 —	—	A	5 A 10 —	—	—	8 + 7 —	—	—
Strept. salivarius	1	R	A sl. R soft C	4.6	+	A	A	—	A	—	—	+	—

A = acid.
R = reduction.
C = clot.

+ = positive result.
— = negative result.

hæmolytic coccobacillus, but the results of Tweed and Eddington (1931) show that serologically identical non-hæmolytic strains do exist. Its pathogenicity for laboratory animals is low. A serum broth culture of one strain was given to mice intraperitoneally. One ml. of the original culture killed mice but 0.5 ml. of the sixth mouse passage was not consistently pathogenic. The main characteristics of this organism are given in Table II. It was also found that all strains fermented arabinose, dextrin galactose, lævulose, sorbite and xylose but none fermented adonite, dulcite or glycerin. The fermentation of inulin and rhamnose was variable. Saline suspensions of the five strains

TABLE II
Characteristics of Hæmolytic-coccobacillus. B. bovisepticus Group I (Jones, 1921)

	Hæmolysis	Litmus Milk	Indole	McConkey plates	†Fermentation of: Glucose	Maltose	Mannite	Lactose	Saccharose	Salicin
B. boviseptica Group I Jones (1921)	±	A	—	+	A	A	A	A slow	A	—
Tweed & Eddington (1930)	±	A	—	+	A	A	A	A slow	A	—
Lovell & Hughes (1935)	+	N	—	+	A	A	A	A slow	A	—
Montgomerie *et al.* (1938)	+	N	—	.	24 A 4 —	A	A	— 4 —	A	—
Five strains here recovered	+	N	—	—	A	A	A	1 A	A	—

A = acid formation.
+ = positive.
— = negative.
. = not tested.
N = neutral.
† Brom-thymol-blue indicator used in this study.

were tested against four Group I and three Group II agglutinating sera (Montgomerie *et al.*, 1938). These sera were kindly supplied by Mr. Glover and it was shown that one strain was antigenically related to Group I and another to Group II, but there was some cross agglutination. The remaining three strains were antigenically distinct as are Jones Group I strains.

A hæmolytic diphtheroid which exactly resembled *C. pyogenes* when incubated aerobically in deep or surface blood agar plates was isolated on seven occasions. The growth and hæmolysis of this organism was little affected by changes in the oxygen tension. The strains were less strongly gram positive

than *C. pyogenes* and the morphology of the bacterial cells varied with the period of incubation. After twenty-four hours on egg medium the diphtheroid type predominated but it was shorter than, and not arranged in the characteristic manner of, *C. pyogenes*. After seventy-two hours' growth forms up to 2.2 m. long were observed, some being slightly beaded. The organism is non-motile. The growth on the egg medium assumed a white appearance different from that of *C. pyogenes* and the medium was not liquefied. Solid serum and gelatine were not liquefied and there was no change in litmus milk. All strains fermented arabinose, dulcite, galactose, glucose, glycerin, inulin, lactose, maltose, mannite, saccharose and salicin. The organisms were non-pathogenic for mice when inoculated intraperintoneally and preliminary work suggests that the hæmolysin differs immunologically from that of *C. pyogenes*.

Results of Examining the Vaginas of Forty Dairy Cows

The primary plates were sterile in two cases, on eight occasions non-hæmolytic colonies only were observed. In the remaining thirty, streptococci giving strong alpha or a greenish zone of hæmolysis were grown. Twenty-eight strains were examined further and fifteen resembled *Str. acidominimus*. This name was given to an organism isolated from milk by Ayers and Mudge (1922) and since then by Little (1940) from the udder and by Smith and Sherman (1939) from the vagina. (See Table I.) Eight strains hydrolysed sodium hippurate, the seven other strains failed to do so but resembled *Str. acidominimus* in all other respects. One strain each of Mastitis Group II and Mastitis Group III streptococci, and of *C. pyogenes* were isolated. *Str. agalactiæ* was not recovered.

Discussion

In bovine mastitis caused by *Str. agalactiæ* it is probably true that infection is usually via the teat canal, and that the infected udder is the main reservoir of this streptococcus. Bryan (1938) found that, whereas large doses of *Str. agalactiæ* culture failed to produce mastitis in four cows when administered s/c, intravenously or *per os*, the same cows could be infected via the teat canal. Ayers and Mudge (1923) failed to isolate *Str. agalactiæ* from the mouth or the fæces, and Smith and Sherman (1939) from the vagina of cattle. On the other hand direct udder to udder infection does not fully explain the epidemiology of this disease and *Str. agalactiæ* has been recovered by Australian workers (*Bull.*, 1940) from the fæces of seven cows and from sores in the teats of two. They believed that the partial success which is obtained by the removal of infected cows may possibly depend in large part on the removal of susceptible animals rather than solely on the removal of the reservoir of infection. The present study has not shown that the tonsil or vagina is the source of *Str. agalactiæ*.

It is generally recognised that mastitis due to Group II and III mastitis streptococci; (Minett, Stableforth and Edwards, 1932) staphylococci; (Minett,

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1937; Plastridge *et al.*, 1939); and hæmolytic streptococci (Minett and Stableforth, 1931), which have now been shown to belong to Lancefield's Group C, is sporadic in nature and that there is some other source of infection than the udder. All these organisms have been isolated from the tonsil and Group II and III mastitis streptococci from the vagina. It is therefore suggested that these sites may under some circumstances act as reservoirs of infection for mammary tissue.

The same view may be put forward concerning *C. pyogenes* mastitis which is often associated with certain weather conditions and with flies. The endogenous development of the disease due to this organism is probably the rule, for there is undoubtedly a high carrier rate in bovines. Not only is there direct evidence but also indirect; Lovell (1939) explains the distribution of *C. pyogenes* antitoxin in the sera of bovines along these lines. The fact that *C. pyogenes* is one of the organisms most frequently recovered from internal suppurative conditions in cattle suggests that bacteriæmia due to this organism is common. It is possible that some factor may increase the carrier rate of *C. pyogenes* and facilitate its entry into the blood stream, or its localisation in the udder.

Calf pneumonia may be associated with the presence of *C. pyogenes* or the "hæmolytic coccobacillus." Adverse weather and hygienic conditions predispose to this disease and the finding of these organisms in the tonsil has a bearing on the subject, for it is possible that the bacteria associated with pneumonia are often lying latent and only become pathogenic when host resistance is lowered. A similar hypothesis may be put forward to explain the origin of the condition known as "transit fever" in adult bovines.

Summary

(1) One hundred pairs of bovine tonsils have been examined bacteriologically. The predominant organisms grown on blood agar plates were gram negative coliform rods and streptococci which gave zones of greenish hæmolysis.

(2) Eighty-seven strains of streptococci were examined and the following were identified:—

Mastitis streptococcus Group II—5.
Mastitis streptococcus Group III—7, with an additional 8 strains which differed in some minor way.
Hæmolytic streptococcus Group C (Lancefield)—9.
Enterococcus—6.
Str. salivarius Group I (Safford, Sherman and Hodge)—1.

It is pointed out that the five strains isolated in this study which exactly resembled Group II mastitis streptococci could equally well have been included in *Str. salivarius* Group II of Safford, Sherman and Hodge.

(3) The following were also isolated:—

C. pyogenes	18 times
Staphylococcus aureus	4 „
Hæmolytic coccobacillus	6 „
Hæmolytic diphtheroid	7 „

(4) From swabs taken from the vaginas of forty cows the following were recovered:—

Mastitis streptococcus Group II—once.
Mastitis streptococcus Group III—once.
C. pyogenes—once.
Str. acidominimus—15.

(5) *Str. agalactiæ* was not isolated from the tonsil or vagina.

(6) The possible role which certain of the bacteria found in these sites may play in the development of mastitis and pneumonia is discussed.

My thanks are due to Mr. J. R. Hayhurst for permission to obtain the heads of the slaughtered cattle and to Dr. A. W. Stableforth for facilities for testing strains of streptococci serologically. I am indebted to Dr. F. C. Minett and to Dr. R. Lovell for their advice and help during the course of this work.

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SWEAT-GLANDS OF THE DOG

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LITTLE attention has been paid to the clinical significance of sweat-glands in the dog, and there is a popular belief that the dog has no sweat-glands.

Hirt in 1923 showed that sweat-glands occurred in all races of dogs that he examined.

Mr. R. H. Duff, in the Department of Pathology in the R.(D.)V.C., noticed the frequency of occurrence of adenomata containing sweat-glands in the skin of dogs, and it seems reasonable to suggest that in other skin-diseases of dogs the sweat-glands may be involved.

The physiological importance of the dog's sweat-glands is rarely considered. In Smith's *Veterinary Physiology* (1912) the statement is made that: "It is certain that the dog and cat, especially the latter, sweat freely on the foot pads as also on the muzzle, though not on the general surface of the body."

It is interesting to quote from the references collected by Hirt in his *Dissertation*. He remarks that most of the research into the sweat-glands of dogs is dated between 1860 and 1900. He includes quotations from:—

Carsten Harms (1868): who found the sweat-glands of the dog to be large and numerous. Their situation is not as deep as the roots of the larger hairs. He stated that the dog can sweat, but the sweat-drops are not visible because the hairs are too numerous. "The grape-like glands of the skin are not found in the hairless regions and their form and shape are variable."

Paul Jess (1896): writes that in the hairy parts of the dog the skin between two hairs is folded. Around the hair-follicle there are two glands, "not as Bonnet found, only one gland." Sweat-glands do not appear at all, but there are sebaceous glands which bear a slight similarity to sweat-glands on the cheek. In the regions of forehead and neck there are no sweat-glands but there are small ducts very similar to those of sweat-glands but which are actually only the opening of hair-follicles. Further, the underpart of the neck, the withers, the breast, and the anterior part of the foot have no sweat-glands. His conclusion is that he could find no sweat-glands in the skin of the dog although there are two kinds of sebaceous glands, tubular and racemose.

Jess quotes from Bonnet: "Real sweat-glands were not discovered in dogs in the parts of the skin I searched, with the exception of the nose, a part without hair."

Kormann (1905): In all of the five dogs of different breeds and sizes, not one had a gland on the naso-labial plane and I searched very thoroughly the bare part of the muzzle.

Hairy part of muzzle Greyhound.

Inguinal region. Mag. x 100.

Skin of a digital pad of a 2-days-old Fox-terrier.

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Sweat gland and sebaceous gland on opposite sides of hair-follicle. Mag. x 190.

Maxillary region. Adult Cairn Terrier.

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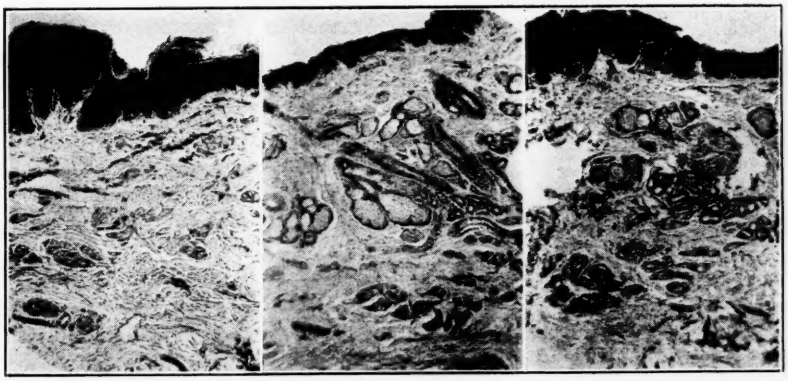

Hairless part showing absence of glands. Hairy part of muzzle. Junction of hairless and hairy parts of Muzzle.

Sections from Muzzle of Adult Greyhound. Mag. x 45.

Sweat glands. Maxillary Region. Adult Cairn Terrier. Mag. x 560.

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Gylek (1912): "Nevertheless I am convinced that there are no glands. I searched the sections of the bare part of the muzzle very thoroughly and not once did I find even a trace of a gland or a rudimentary gland."

Backmund (1904): From research on sweat-glands and hair in cats Backmund concluded: that the development of the sweat-glands on the hairy part of the skin of cats is from the hair-building parts, the sweat-gland developing from the epithelial invagination by mitotic division of the outer layers of cells as a bud. The primitive gland has a rounded acinus which passes without sharp demarcation into the duct. The sweat-glands of the lower and upper jaw have a special shape, at the end of their development forming irregular tubes without a large base, but reverting in extra-uterine life. Any other forms of embryonic sweat-glands are very rare in the cat. He found that each fœtal hair has a sweat-gland but that there are no free openings of sweat-glands.

Stoss (1906): "Sweat-glands in dogs are simple and tubular and have a fluid or fatty secretion according to the kind of animal, the enervation and the region of the body; definitely both sweat and sebaceous glands appear in all races of dogs. The sebaceous glands are most evident in the races with short hair and the sweat-glands in dogs with long, fine hairs." Stoss suggests the sweat-glands in a very hairy skin may be comparatively rare and difficult to find, and in some breeds may remain in embryonal form. But in general they may be found in all regions of the skin. "The sweat-gland has a funnel-shaped opening into the hair-follicle roughly 300 μ from the surface of the skin. The form of the gland is such that the funnel-shaped opening leads into a thin straight duct with a double layer of cells roughly 250-300 μ in length and this continues, after a sharp bend, as the secretory part, which is 50 μ in diameter, strongly convoluted, and extending to the root of the hair or a little farther. In some cases the sweat-gland diverges from the hair-follicle. The epithelium is low cubical and the lumen is wide and filled with coagulated secretion."

Stirling (1875): Found that the funnel-shaped opening of the sweat-glands was situated higher than the sebaceous glands, entering a follicle common to several hairs.

Gurlt (1835): Was the first to record research into sweat-glands of horses, cattle, pigs and dogs; he found: "In all hairy parts the sweat-glands are small and elongated, not very curved, and not easily found."

Chodakowski (1871): According to Chodakowski the sweat-glands open into the hair-follicles and are deeper than in other domestic animals. Exceptionally there are free openings.

Gray: Found the sweat-glands in dogs small with a funnel-shaped opening on the skin near the hair-follicle. He said that the musculature of the duct of the sweat-gland is supposed to function as arrector pili.

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Brehms (1915): On page 235 there is a passage about sweating in dogs.—"Dogs sweat little even when running fast and long. The saliva acts instead of sweat and drops from the tongue which the dogs, when they are hot, stretch out from the mouth."

After making this survey of the scanty literature relating to sweat-glands in the dog, Hirt describes his own findings: He states that the best-developed sebaceous glands are on the lips, back, and lower part of the breast, and summarises his conclusions about the dog's sweat-glands:—

(1) For research into the sweat-glands of dogs the back region is best.

(2) Sweat-glands in dogs are not numerous.

(3) Contrary to the opinion of Stoss, on the hairy parts of the body, especially on the back, they are most numerous, best developed, and easiest to find.

(4) In different breeds the number of sweat-glands changes in different regions.

(5) The kind of hair, stiff or soft, has no influence on the appearance of the glands.

(6) Stoss expresses that the opening of the gland becomes confluent with the hair-follicle, but it would be better to say that the broader part of the follicle at the surface is a direct continuation of the duct of the gland.

(7) The ducts of the sweat and sebaceous glands open as a common duct into the hair-follicle, which is wide and roomy. Therefore the evaporation takes place in the skin, where there is a big surface for the evaporation, and the secretion goes out, aided by the temperature of the skin as vapour, not as fluid drops.

Methods and Findings

For the purposes of this work sections were cut in series from various regions of the skin of dogs. Six breeds of dogs were examined—Airedale, Cairn terrier, Collie, Greyhound and Fox terriers. In the older animals considerable difficulty was experienced in cutting the hairier parts, because the thick hairs caused the sections to split, but it was found possible to get complete series from the skin of a two days' old Fox terrier bitch. Comparison between sections cut from the skin of this young animal, and sections from the skin of an older animal, showed similarity in the number and distribution of the sweat-glands, while in the young animal the hairs did not obscure the field so much.

The sections in series from this two days' old animal were useful in following the course of sweat-glands. Pieces of skin were cut from each region of the body to be examined, fixed in formalin and blocked in paraffin. Sections of these were cut in series, mounted and stained with H and E.

Sweat-glands could be seen in most of these sections. In form the sweat-

glands varied in different regions, but in general they could be described as flexuous tubules running nearly parallel with a hair-follicle, but not lying as deep as the fundus of the larger hair follicles.

At the level of the sebaceous gland, the lumen of the sweat-gland narrows, forming what may be described as a duct which passes over the surface of the sebaceous gland and then continues upward on the outer surface of the follicle. The opening of the sweat-gland is by means of a wide "funnel-shaped" opening into a dilated part of the follicle roughly midway between the opening of the sebaceous gland and the surface of the skin. The histological structure of these sweat-glands is quite typical of functioning apocrine glands, and the characteristic layer of plain muscle fibres between the basement membrane and the single layer of epithelial cells can be clearly seen.

There are distinct modifications in the appearance of the sweat-glands in different regions of the skin, and in some areas sweat-glands are absent.

On the hairless part of the muzzle there are no sweat or sebaceous glands, and the epithelium of the skin is very thick. At the junction of hairy and hairless parts of the muzzle the epithelium is thinner and each hair has a large lobulated sebaceous gland with a small convoluted sweat-gland situated below the sebaceous gland. Here also the "duct" of the sweat-gland passes over the mass of the sebaceous gland and enters the hair-follicle above it.

On the upper and lower lips the sweat-glands are large, numerous and well-developed. They are distinctly sinuous. The large tactile sinus hairs have no sweat-gland related to them.

The remainder of the skin of the head has sweat-glands which are less sinuous and smaller.

The skin on the back has very numerous sweat-glands, and these are large, well-developed, and of the typical flexuous appearance, but the hairs in this region are so numerous that it is possible on a single section to confuse the sweat-glands with the smaller hair-follicles.

On the thorax, shoulders, and thighs the sweat-glands are numerous, and the typical grouping of hair-follicles, sebaceous-gland, and sweat-gland is easily seen.

The skin of the abdomen and groin has fewer hairs, but each larger hair has its sebaceous gland and sweat-gland, the latter being very sinuous so that it is cut through in several places in a section.

On the scrotum the sebaceous glands are greatly developed, forming an almost complete lobulated layer and sweat-glands are not evident. A similar appearance is seen in the perineal region where the circumanal glands form a dense mass.

The sweat-glands of the pads of the feet are peculiar. Hairs are absent, and the sweat-glands have a modified "coiled gland" appearance. They are very numerous, or perhaps it is better to say that they are easily seen because

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they are coiled and there are no hair-follicles with which they can be confused. Their ducts lead upward to the surface, where each duct is seen to be a continuation of an invagination of the epithelium. This invagination resembles the "neck" of a hair-follicle and has a lumen. The stratum corneum dips down into this lumen and in the sections cut from the pad of the young animal no openings could be found through the stratum corneum from the sweat-gland to the surface. In the older animals the "ducts" of the sweat-glands continue through the thickened stratum corneum as large tortuous passages to open on the surface of the skin.

Conclusions

1. Sweat-glands in the dog are numerous.
2. They occur in a simple uncoiled form on the hairy parts of the body.
3. In the pads of the feet they are coiled.
4. With the exception of those in the pads of the feet all sweat-glands in the dog open into hair-follicles and have the appearance of buds or branches of the hair-follicle.
5. Contrary to Hirt's finding, the opening of the sweat-gland into the hair-follicle is separate from that of the sebaceous gland, and nearer the surface of the skin.

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FIG. 1.—The first photograph was taken a few days before the operation.

FIG. 2.—This photograph was taken 38 days after the operation.

Although some swelling of the cheek is still present, it is anticipated that in the course of time this will practically disappear. The danger of metastasis must not, however, be overlooked.

Clinical Articles

GRANULOMATA OF THE CHEEK OF A SHIRE GELDING

By CHARLES WEIGHTON, M.R.C.V.S.
Lincoln

On April 3, 1941, an examination was made of a 13-year-old dark-bay Shire Gelding which had what was at first thought to be a fibroma about twice the size of a cricket ball—deep seated in the cheek on the off-side, and extending to the commissures of the mouth. At the distal end of, and largely below the facial crest, was a second more circumscribed growth not more than one-sixth the size of the first. Both, or at least one of the growths, was reported to have been present when the horse was bought as a three-year-old, and the larger one had gradually increased in size until the usefulness of the animal looked like being impaired. The submaxillary lymphatic gland on the same side was slightly enlarged. There was a small break in the skin immediately below the highest point of the larger growth, no doubt caused by friction from the bridle. The horse showed no pain and ate normally, although partial paralysis of the lower lip caused it to hang 1½ inches below the upper lip.

Under local anæsthesia a small section of the growth was removed from the site of the small abrasion. Dr. Tom Hare reported on the section as follows :—

" On histological examination the tumour proves to be a granuloma. It arose, like the botriomycotic growth, shoulder tumour, girth gall or scirrhous cord, as the result of local infection by such organisms as streptococci or staphylococci. While surgical removal may be practicable, I suggest that in addition you should administer a course of Equine Pyæmic Vaccine, since the infection is likely to be present in the deeper parts of the growth and it may result in your operation wound being re-infected unless the horse is vaccinated."

The owner was advised of the various difficulties to be overcome in attempting to remove the larger growth, particularly because of its undefined base, the fact that it extended to the buccal mucous membrane, and of the possible danger of surgical interference promoting new growth of tissue.

Before attempting surgical treatment it was decided on April 29 that it might prove an advantage to ligature the growth, in this way cutting off the major blood supply and so avoid excessive hæmorrhage—which seemed one of the greatest dangers—and thus facilitate removal.

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Regional anæsthesia was successfully produced by injecting 6 to 8 c.c. of "Chlorocain" into the infra-orbital foramen which was relatively easily felt, about 1½ in. above and in front of the facial crest, by pushing upwards the M. Levator labii superiorus proprius, which passes over the foramen.

Four or five ligatures were inserted without re-applying the twitch.

The smaller growth was dealt with similarly with the addition of local anæsthesia. An injection of tetanus antitoxin was then given. The attendant was instructed to keep the areas clean, to dress where necessary with a weak antiseptic solution and to apply a fly repellant round the area involved.

The ligatures were, as far as possible, tightened a week later and again in four days' time. The result did not prove to be very satisfactory as the amount of congestion near and beyond the ligatures was more than expected, while there was a marked tendency for the tissues to reunite. The Equine Pyæmic Vaccine was given every second day from May 1 to 7 and the final injection on May 14—a total of 30 c.c. being administered.

The horse received no food during the 24 hours prior to operation, and was kept on half rations for 24 hours preceding this period.

On June 4 narcosis was induced by an intravenous injection of one ounce of chloral hydrate in a quart of warm water at blood-heat containing sodium citrate. In a few minutes the horse was unsteady on his feet, and was cast comfortably by side-lines. Before the operation was completed a second intravenous injection was given consisting of half of the first dose.

Regional anæsthesia was produced as before. Three or four silk ligatures were inserted 1½ inches from the larger growth, and the skin incised between these and the first ligatures.

Incising from the upper extremity, about three-quarters of the enlargement was removed first; then the remaining portion by a more careful dissection at its junction to the healthy tissue, and especially where the growth approached the buccal mucous membrane.

Tetanus antitoxin was administered. The patient was then allowed up and taken to a loose box. Little general disturbance took place and he improved in condition after the first few days.

The packing and the ligatures were removed in two days, the cavities treated as open wounds, and cleansed daily with a Hewsol solution.

The larger wound was also dressed for ten days with a five per cent. silver nitrate solution, for the following week with powdered copper sulphate and during the remainder of the healing process with sulphanilamide powder (M & B).

The greatest amount of pus formation appeared on June 21, but this was largely removed by pressure round the upper edge of the wound. From then onwards the swelling began to subside more rapidly.

The right submaxillary lymphatic gland was enlarged still more but soon subsided to its original state.

Considerable hæmorrhage occurred at the junction of the diseased and healthy structures but was kept in check by swabbing. Only once was the field of operation obscured, when a relatively large artery entering the growth at its deepest point had to be ligatured.

The tumour was otherwise poorly supplied with blood vessels. After removal, the base was lightly curetted, the whole area cleansed with a Hewsol solution, the cavity packed with pieces of cotton wool wrapped in strips of bandage, and two sutures inserted to retain these in position.

A portion of the growth was left at the commissures of the lips because of the danger of interfering with prehension, and of rendering the horse unsightly. The excised tissue was greyish-white in colour, harder than the average fibroma, and more closely resembled cartilage in consistency. The smaller growth was excised after the addition of local anæsthesia and the cavity packed as in the first instance.

Owing to unavoidable damage to nerve branches a partial paralysis of the upper lip occurred, which was pulled to the near side.

The paralysis had completely disappeared before the wounds had healed. The lower lip showed no alteration.

Four weeks after the operation the horse was fit for light work.

I am indebted to Dr. Tom Hare for his report and valuable help in this case, and to Professor J. McCunn for further inspiring advice, which gave one courage to carry out what, at first, seemed no mean surgical procedure.

Abstract

HYGROMA OF THE BOVINE CARPUS

By T. H. FERGUSON, V.S.

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HYGROMA is frequently encountered in stabled cattle. It may be a sequel to a sudden, direct injury, but it is more commonly caused from constantly striking the knee against the feed trough or floor when rising. Sometimes in stretching to get food beyond its reach the animal slips to its knees and is injured. More cases develop during a winter following a drought when bedding is scarce and the animals have to lie on bare floors. When hygroma occurs among pastured cattle, it is always due to a sudden, direct injury.

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Hygromas Classified

The following is a fairly satisfactory classification for the more common hygromas: (1) an acute bursitis which is not commonly noticed; (2) a chronic, serous bursitis or typical hygroma; (3) a suppurating swelling due to infection of the injured part; and (4) a diffuse, fibrous enlargement.

In handling any hygroma, the first important consideration is to prevent further injury. If this is not done, treatment is useless. A good place for an afflicted animal before treatment, as well as after, is a stall that has been covered with dirt arranged in such a manner as not to spread. The dirt, in turn, should be covered with ample bedding. If the animal is kept in a stanchion, the stanchion support should be padded to prevent further injury. An ideal confinement after operation is a box stall prepared in the above way.

Treatment

Acute bursitis, which is manifested by pain, heat and swelling of the part, usually responds promptly to the following treatment. Apply ice for six hours. To handle the ice conveniently, use an automobile inner tube. Stretch the tube over the leg and bandage tightly from the foot to the middle of the metacarpus, providing an opening for the claws. Pack the inner tube to just above the knee with crushed ice. Support the bandage over the animal's neck and withers and around the other leg. Follow the six hours of ice treatment with six hours of treatment with hot applications. This can be accomplished by wrapping several thicknesses of absorbent cotton around the knee, holding in position with bandages, pulling the inner tube back into position, and applying hot water.

Follow this hot treatment by the application of 1 dr. each of oil of organum and oil of cedar, 0.5 oz. of iodine crystals and 1 pt. of wood alcohol. Apply to the affected parts with a brush twice daily until the skin shows soreness. Discontinue until the condition of the skin is normal. If slight swelling remains, repeat the medication.

It is fortunate when hygroma is noticed in the stage of acute bursitis, for that is the best time to treat the condition.

When the condition has progressed to the stage of a chronic, serous bursitis or typical hygroma, there are several methods of treatment from which good to fair results may be expected. In pure-bred animals, or in others where the expense and bother are not taken into consideration, a flap operation may be performed, and the sac removed by dissection. After dissection is complete and hæmorrhage is controlled, the judicious trimming and suturing of the flap make a very satisfactory finish, providing that the leg was properly prepared for the operation, the operation performed under aseptic conditions, and the knee joint completely immobilized after the operation and until healing was complete.

Operative Procedures

To prepare the leg for the operation, clip it and shave over the entire

swelling. Scrub thoroughly with soap and water. Follow with alcohol thoroughly rubbed into the skin. Bandage with absorbent cotton and gauze bandages from the foot to well above the knee. Cover this with an inner tube, supported over the neck to the other leg, and keep the bandage soaked for 24 hours with a 1 : 1,000 solution of bichloride of mercury.

Our operative technique is as follows: Restrain the cow with the affected leg uppermost. In some cases, it is well to strap the leg to a 2 x 4 or a smooth board after applying a tourniquet above the knee. Anæsthetize with chloroform. For a medium-size swelling, one flap is sufficient. Make the flap on the inside, cut through the skin, dissect out the flap and suture it to the outside of the leg. This gets the flap out of the way.

Dissect out the sac, ligating the larger vessels, cauterizing the smaller ones, until the entire sac or fibrous growth is removed *en masse*. Trim the flap, but leave sufficient skin so that there will be no tension on the suture. It is much better to have too much flap than too little; nature seems to take care of the extra skin.

After the flap is sutured in position, dress the parts with etherized iodoform and a liberal supply of powdered boric acid. Cover with absorbent cotton and bandage with gauze bandage. Apply a metal splint cut to conform with the shape of the leg and concave to fit. Apply a splint front and back. Fasten with rope or bandage. This dressing should be removed in three days, at which time, if the condition of the wound is favourable, etherized iodoform and boric acid powder should be administered liberally, followed by the application of a plaster of paris cast from the hoof of the middle third of the radius. Do not cover the claws. To enhance the hardening of the cast, use about 10 per cent powdered alum. This kind of cast hardens quickly.

If the case progresses favourably, leave the cast on for three weeks, by the end of which the wound should be fairly well healed. If the animal is kept in a stall, it should be well bedded to prevent injury to the other knee, which will have to be used exclusively in getting up. Should both knees be affected operate the larger hygroma first, and after it has healed, the other may be operated.

Another operation that we have used successfully for this condition is as follows. Either prepare the growth as described above, or clip the hair and apply tincture of iodine. Puncture the growth at the superior surface, or in several places if it is honeycombed. Remove all fluid possible and carefully inject formalin. It may be necessary to tap in two or more places. In tapping, it is better to introduce the trocar obliquely, as this procedure forms a valve which tends to keep the gas in. In about ten to twelve days, the entire sac will be loosened and may be removed from an incision on either side. Under this method, hæmorrhage is not severe. It also leaves a nice bed of granulations, and the wound will, if sutured and the leg immobilized, heal satisfac-

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torily. The sac may be removed in its entirety or, if a smaller incision is desired, it may be divided and removed in parts. Immobilize the leg either with splints or a cast to be left on until healing takes place unless contra-indications develop.

A third method for handling a typical hygroma, especially of the serous type, is to prepare the enlargement, thread a seton needle with the end of a 4-inch, 10-yard bandage. Restrain the animal and leg, thrust the needle through the bunch from inside out at about the middle of its lower third. Unroll a sufficient amount of the bandage to pack the cavity. Saturate this with tincture of iodine and thoroughly pack the cavity. Use the balance of the bandage to circumscribe the swelling and leg. Since there is always considerable hæmorrhage in these cases, it is well to apply a tourniquet well above the knee. The tourniquet can be removed just after bandaging. In severe cases, the bandage should be cut and removed in 48 hours, leaving enough of it to make a seton.

The interior should be loosely packed with iodine gauze for seven days. If such a sac is complicated, with fibrous bands or growths, they should be removed with a curette or scissors. If circumstances permit, the leg should be immobilized with splints or a cast; if not, the animal should be kept in the pasture or in a stall with a dirt bottom and plenty of bedding. With just ordinary attention, animals will make a fair recovery under this procedure of treatment.

Abscessed hygromas should be handled in much the same way. In cases where the growth assumes the size of a water pail—unless the animal has extraordinary value—and in cases where the joint proper is affected, the animal should be slaughtered.

Abstracts of Current Literature

Discussion on Swine Influenza in the British Isles. *Proc. Roy. Soc. Med.*, 1941, *XXXIV*, 611.

F. Blakemore and A. W. Gledhill described five outbreaks in East Anglia. In outbreak T/1 there was no previous history of the disease and although pigs of all ages were on the farm, only the 8-14 week old animals were affected. Sneezing was the most characteristic feature and severe cases developed symptoms of pneumonia and prostration. Delirium was noticed in a few at the height of the attack. The course of the disease was usually short but following pneumonia unthriftiness was present for some weeks and a chronic

cough persisted. Post-mortem examination showed catarrhal changes in the nasal cavity and in most cases the lungs were also involved. Bronchopneumonia was seen in sections of affected lungs and there were also areas of collapse. The extent of the lung lesions varied but they were mainly found in the apical, cardiac and intermediate lobes. *Hæmophilus influenzæ* was recovered from three of five cases examined. The authors were able to set up the disease in young pigs readily by the nasal instillation of Berkefeld filtrates of the lungs and turbinates from affected animals. Work was also carried out in ferrets and by passing the infective material through a series (nasal instillation) acute symptoms were obtained. A typical "influenza" temperature reaction and sneezing were the important clinical finds in the ferret with, in some cases, signs of pneumonia. The virus passed in the ferret was infective for pigs. Confirmation that the virus with which the authors were working was indeed identical with, or closely related to, that causing the natural disease was obtained from the results of neutralising tests with blood from convalescent pigs on the affected farm.

In outbreak S/1 pigs 10-14 weeks old were affected. In this outbreak sneezing and nasal catarrh were not prominent symptoms but the occurrence of pneumonia appears to be greater than in the former case. Pleurisy and pericarditis were also found. Normal pigs and ferrets were infected with emulsions of lung material. From the lungs *Pasteurella suiseptica* and *Brucella bronchiseptica* were isolated as well as Gram positive bacilli from the pleura and pericardium.

Outbreak H/1 concerned a group of young pigs, mixed together after weaning. Pneumonia occurred in some after an illness lasting five days while, in others, the disease became chronic. Enteritis was also present in some of the infected animals. Pneumonic lesions, as above, were constantly present. From the lungs, cultures of *Pasteurella, Br. bronchisepticus* and diplococci were isolated but the various organisms were not constantly present in any animal. Normal pigs and ferrets were infected as before.

G/1 was an outbreak in which the history was that some of the young pigs became affected after weaning. Sneezing was observed: there was no evidence of enteritis. The lesions were confined to the lungs. *Hæmophilus influenzæ* was recovered from the lungs and, in addition, cultures of streptococci and Gram positive bacilli were isolated. Transmission to normal pigs was effected but not to ferrets.

In outbreak C/1 the disease appeared among pigs 10-14 weeks old which had been purchased. There was only a low mortality but unthriftiness was marked. The characteristic feature of the outbreak was the occurrence of pneumonic symptoms; pleurisy and pericarditis were also found. The bacterial findings are stated to be similar to those in outbreak H/1 except that *Hæmophilus influenzæ* was also recovered from the lungs of one of the pigs.

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Transmission was successful in normal pigs but could not be established in ferrets.

In addition to the above outbreaks, the authors examined the lungs of pigs at a slaughter-house. They found that in at least 25 per cent. of the pigs pneumonic lesions resembling those described above were present. The stage of development of the lesions varied greatly and in many, resolution was complete. The lungs of 40 pigs were examined and from three *H. influenzæ* was recovered. Streptococci, *P. suiseptica, Salmonella* and Gram positive bacilli were also isolated. Evidence of the presence of virus was obtained in the lungs of one pig: transmission to the ferret was effected by the use of a filtrate. With emulsions from the lungs of two pigs, the disease was transmitted to normal pigs.

In discussing their results the authors state that their "findings indicate that an infectious pneumonia of pigs occurs in this country" and that the condition is not uncommon. The clinical picture is not the same in all outbreaks but the presence of a virus, as shown by the transmission of the infection to ferrets and the recovery of *Hæmophilus influenzæ* from a proportion of the cases strongly suggests that the disease in question is influenzal in character. A comparison of the disease with swine influenza as described in America is given. In both diseases it is recorded that pigs 10-14 weeks are affected but whereas the disease in this country appears to give rise to a chronic unthriftiness, the American workers emphasize the acute nature of the disease with rapid recovery. Again, Blakemore and Gledhill did not recover *Hæmophilus influenzæ* in all their cases but several types of organisms and thus their findings are more in agreement with those of McBryde and others rather than with those of Shope who lays much stress on the association of *H. influenzæ*.

Again, the findings of the two authors closely resembled those of swine influenza in Northern Ireland. They worked with material sent by Lamont and succeeded in setting up a mild disease in ferrets with it. The only great difference between the general features of the diseases in England and N. Ireland appears to be that in the latter country unweaned pigs are affected. This is also true of the diseases in Germany where chronic cases are common.

In one of the outbreaks it was shown that the virus persisted in the lungs for a considerable time, for it was recovered from a pig which had been ill for eight weeks.

The authors were unable to obtain evidence that parasites played any part in the development of the disease.

R. E. Glover discussed the antigenic composition of the viruses from cases of pig influenza. He quoted Andrews, Laidlaw & Smith, who found that in the sera of adult human beings and from children over 10, antibodies to swine influenza (American virus) were present "as regularly as those active against

the human viruses." He discussed work carried out by Andrews and himself in which attempts were made to transmit the pig viruses to mice. By nasal instillation under ether anæsthesia of the supernatant fluid from centrifuged suspensions of the material and by further passage a number of mice developed lung lesions. They found that the Cambridge strains (supplied by Blakemore and Gledhill) were apparently much less readily adapted to mice than those examined by Shope (American strains). Strains from N. Ireland were also examined and one was eventually adapted to mice. Filtration of the strains through gradocol membranes was carried out and results are given of their size.

From the results of immunity work in mice carried out with two Cambridge strains, the N. Ireland strain and a Shope (American strain) Glover states that " Our immunological studies are incomplete, but at present they seem to indicate that the British pig strains form a less compact group than the American strains and serologically are rather different from them. It is by no means certain that they are as clearly separated from the human viruses as are Shope's strains; possibly they will bridge the gap between human and American porcine influenza viruses."

E. L. Taylor discussed the worm-transmission theory concerning swine influenza viruses. He referred to other diseases in which it is claimed that microscopic or ultra-microscopic infection by parasitic worms takes place. He referred to some work carried out by Purchase and himself in which he made a series of observations to ascertain whether penetrating nematode larvæ or adult strongyloid worms might assist the invasion of the animal body by bacteria from the intestine. *B. anthracis* and *Salmonella suipestifer* were used. They found no evidence of any action on the part of parasitic worms in assisting the bacterial invasion. He also referred to " blackhead " in turkeys, " footrot " in sheep and " salmon poisoning " as examples of transmission by parasitic worms. His conclusions are " in the presence of alternative explanations concerning the prevalence of swine influenza, the indefinite nature of the symptoms sometimes shown and the possibility of animals already carrying the infection unknown to the investigators, the lungworm theory cannot be accepted as a complete explanation."

Clinical Observations on the Use of Sulfapyridine in the Treatment of Canine Distemper. By ARTHUR H. BRYAN, Baltimore, Maryland (Science Department, Baltimore City College). Reprinted from *Veterinary Medicine.* July, 1941.

THE sulfonamide group of drugs dominates all other chemotherapeutic agents in recent medical literature, because of their apparently specific action in combating many types of infections. New uses are still being found for these drugs and new derivatives are being prepared in the laboratory with varied therapeutic indications. Sulfapyridine is practically specific in human

pneumonias, particularly lobar. Ketchersid* used this drug in the treatment of 18 dogs suffering from pneumonia, of which eleven cases were secondary to distemper, with encouraging results. The following clinical investigations were based on the thought that sulfapyridine also might prove of value in the therapy of uncomplicated distemper, or of distemper with complications other than pneumonia.

Clinical Material

Canine distemper cases were accepted for these clinical observations only if the animals showed a temperature of over 103 deg. F., rapid pulse and increased respirations, hyperemic membranes, etc., as evidence of the catarrhal, bronchial, intestinal, or skin forms of distemper.

One control group consisted of dogs given ordinary supportive treatment such as might be attempted by the laity. A second control group was given anti-canine distemper homologous serum only. A third group received sulfapyridine *per os* in minimum therapeutic doses, and a fourth both homologous serum and sulfapyridine. Included among the controls were untreated or lay-treated animals suffering from the disease, owned by the neighbours of persons whose dogs were given the course of sulfapyridine treatment. A cocker spaniel kennel of some 150 dogs in which distemper was present gave an excellent opportunity for close clinical observation of treated animals and untreated controls. Some sporting breed kennels with beagles, pointers, and setters were also included in this experiment. In our own hospital, typical cases were brought in for daily observations.

Dosage of Sulfapyridine

We experimented with the dosage, endeavouring to find the smallest effective daily dose which might be given with beneficial results. This was considered important both because of the relatively high cost of the drug and because of the possibility of toxic effects from larger doses. It is known that to be effective a definite concentration of the drug in the blood stream must be maintained throughout its administration, and to effect this it should be given every four to six hours, preferably on an empty stomach. The human dose is generally estimated as 0.5 to 1 gm. (8 to 16 gr.) every four hours, the maximum single dose being 2 gm. and the maximum daily dose 6 gm.† Ketchersid* found a dose of one grain per pound of body weight per day effective for dogs. For large dogs, such as shepherds, St. Bernards, collies, great danes, etc., we gave an initial dose of 10 gr. either four or six times a day, depending upon the size, without toxic symptoms except occasional emesis

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* Ketchersid, James R., 1940. Clinical studies of sulfapyridine in small animal practice, *J.A.V.M.A.* 96 : 758, pp. 661-662.

† Perrin H. Long suggests a six-hour schedule since owing to its lesser solubility the absorption rate of sulfapyridine is slower than for sulfanilamide, for which drug the foregoing schedule was first worked out.

and transient enæmia in protracted cases. In medium-sized dogs, such as chows, spitz, setters and pointers, the initial dose was 7½ gr. four to six times a day. The small breeds, such as scotties, beagles, etc., received 5 gr., and the toy pomeranians 2½ to 4 gr., six times a day.

In practically all instances of acute infections, the temperature fell to normal after two days, after which the doses were tapered off gradually and were stopped by the fifth day, if the temperature and pulse were still normal, and the dog active and lively. Extreme minimum dosages which were found to be therapeutically effective in distemper were 7½ gr. three times a day, with the first dose at about 6 a.m. and the last dose at midnight; or 5 gr. four times a day, for medium and large sized dogs, for 48 hours.

Clinical Records

1. Boston terrier, September 26-30, 1940. Age one year; temperature 103.8 deg. F.; in three days, temperature 99 deg. F., pulse, respiration and appetite normal; complete recovery. Serum and sulfapyridine therapy used.

2. Boston terrier, September 27-30. Age six months; temperature 102.5 deg. F.; normal in three days, temperature 100 deg. F., slight conjunctivitis. Sulfapyridine only.

3. Three beagles, September 28-30. Age four months; temperatures 103.8 deg. F. to 104.5 deg. F. All three completely recovered in three days, temperatures 99 deg. F. to 100 deg. F. Used serum and sulfapyridine therapy. One untreated control, a litter-mate of the other three, died of dysentery, emaciation and anæmia after an illness of three weeks.

4. Belgian shepherd bitch, September 30 - October 2. Age seven months. Temperature 104.5 deg. F.; bronchopneumonia. After three days complete recovery, temperature 99.6 deg. F., no untoward sequelæ. Serum and sulfapyridine therapy.

5. Chesapeake Bay retriever, male, September 26-29. Age five months. Temperature 103.5 deg. F.; skin and catarrhal distemper. In three days temperature was 100 deg. F., with slight dysentery and conjunctivitis; recovered in five days. Sulfapyridine only.

6. Seven cocker spaniels, aged five to eight months. Temperatures 103 deg. F. to 104.6 deg. F.; four had catarrhal distemper, one mainly skin lesions, and two dysentery. Four were given serum and sulfapyridine, three sulfapyridine only. All improved within three days, but the dysentery case took four days for recovery. Three untreated control cases in the same kennel developed chorea or hæmorrhagic dysentery, became dehydrated, and died or were destroyed.

7. Chow, September 9-13. Age one year; temperature 104.1 deg. F.; distemper complicated with otitis media. Recovered in three days, temperature 99.5 deg. F. Serum and sulfapyridine were given.

XUM

8. Scottie, September 4-8. Age nine months; temperature 104 deg. F.; bronchial and skin distemper, conjunctivitis, pharyngitis, and laryngitis. Recovered in four days after being given altogether 52 gr. of sulfapyridine. The dog vomited twice.

9. Two beagles, September 2-5. Litter-mates. Age five months; catarrhal distemper. One treated with sulfapyridine and serum, the other with sulfapyridine only. The latter developed fits and was then treated hypodermically with 5 gr. soluble barbiturate. Recovered in four days. A control beagle in a next-door kennel, receiving serum only, was ill three weeks; became emaciated and recovered slowly.

10. Wire-haired fox terrior, August 21-25. Age 18 months; catarrhal distemper followed by intestinal form of the disease was treated with serum and sulfapyridine; recovered in four days.

11. Pomeranian, August 21-23. Age one year; temperature 104.3 deg. F.; pharyngitis, bronchopneumonia. Serum and sulfapyridine administered; recovered in two days.

12. Mongrel, September 17-19. Temperature 104 deg. F.; catarrhal distemper, extreme malaise. Complete recovery in two days. Sulfapyridine and serum therapy used.

13. Cocker spaniel, September 12-15. Temperature 104.3 deg. F.; catarrhal distemper, conjunctivitis, oral and nasal discharges. Child played with dog while latter was coughing and sneezing, having been sick five days. Child contracted curious undiagnosed pyrexia and was sent to local isolation hospital. Inference—child contracted distemper infection from the dog. This dog received combined serum and sulfapyridine therapy. The child also was given sulfapyridine and recovered. A month later the dog developed local mammary abscess which responded to topical treatment with powdered sulfapyridine.

14. Mongrel, September 11-14. Age four months; temperature 104.2 deg. F.; bronchial distemper. Recovered in three days. Sulfapyridine therapy only.

15. Scottie, September 4-8. Temperature 104 deg. F.; catarrhal and intestinal distemper. Within four days temperature 100 deg. F. Slight anæmia noted. Sulfapyridine only.

16. Spitz, September 1-14. Age seven months; chronic distemper; dog had been sick for three weeks prior to treatment; dysentery, fits, anæmia and emaciation. Forty-five grains of sulfapyridine were given daily. This patient vomited frequently after taking the drug. The owner became discouraged and ordered the dog destroyed one week after treatment began.

17. Collie, August 6-9. Age five years; pneumonia; ill 10 days prior to treatment; developed empyema, died; sulfapyridine therapy.

18. Scottie, August 4-8. Temperature 103 deg. F.; fits and convulsions of nervous distemper. Treated with sulfapyridine only; recovered in three days. Dose 23 gr. a day; vomited once, and a transient anæmia noted.

19. Black collie, August 2-6. Age eight months; temperature 102.5 deg. F.; chronic distemper; had been treated with proprietary medicines without improvement; old hæmorrhagic dysentery; thick purulent conjunctivitis; 30 gr. sulfapyridine administered daily for five days; some improvement evident. Dog destroyed at owner's request. Bowel adhesions noted on post-mortem examination.

20. Dachshund, August 1-4. Age seven years; pneumonia; temperature 104 deg. F., treated with 30 gr. daily of sulfapyridine and serum. Recovered in one week.

Summary of Clinical Records

Thirty-two dogs (of which the records of 29 are given above) were used in these experiments, with 30 untreated controls.

Eighteen animals were given serum and sulfapyridine simultaneously. All recovered except two chronic cases which were destroyed at the owners' request.

Fourteen animals were given minimum doses of sulfapyridine only, four to six times a day. All recovered in three to four days except two chronic cases, which died.

While these results are extremely encouraging, it should be pointed out that the virulence of distemper is known to vary, and that the cases studied may have been due to a relatively mild form of the disease. However, there has been a similarly gratifying response to sulfapyridine therapy in later cases not reported here.

Some 30-odd control cockers and beagles were kept untreated except for possible proprietary remedies. These dogs ran the usual long course of the disease, with subacute or chronic symptoms such as extreme emaciation, dehydration, purulent rhinitis, recurrent pyrexia, or hæmorraghic enteritis, and most of them died or were destroyed because of sequels of chorea or encephalitis. Seven pups recovered slowly. Three recent cases, untreated beagles, still under observation, with catarrhal or intestinal distemper, still show symptoms of pyrexia and general distemper malaise after 10 days.

It has been noted that dogs suffering from distemper often lose their appetite while under sulfypyridine treatment. We are therefore at present stopping the administration of sulfapyridine as soon as the temperature has fallen to normal, instead of decreasing the dosage gradually as was done in the cases recorded. To date, this method appears to have solved the problem; however, further observations are deemed necessary before a definite conclusion on this point can be reached.

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Conclusions

1. Sulfapyridine is apparently a specific therapeutic agent in the treatment of canine distemper in the prodomal or early stages of the disease. Every early case recovered within four days, and the symptoms abated within two days. (Previous to treatment with sulfapyridine, distemper usually ran a protracted course of 10 days to three weeks, and serious sequelæ often ensued.)

2. Sulfapyridine therapy was even more effective when combined with homologous anti-canine distemper serum, as shown by comparative findings.

3. By administration of sulfapyridine bacteriostatic effects were produced within 48 to 96 hours, after which time the dosage of the drug was gradually reduced, with complete recovery usually occurring at the end of the fourth to sixth day.

4. Maximum doses do not appear to be necessary in canine practice. We gave 10 to 35 gr. (0.5 to 2 gm.) per day, depending upon the size and age of the dog, for a period of two to three days, with tapering doses from then on until recovery was complete. Incomplete observations indicate that a better course may be to discontinue the administration of the drug altogether as soon as the temperature has fallen to normal, in order to avoid the loss of appetite which sometimes accompanies the use of sulfapyridine.

5. Sulfapyridine is a specific for canine infections of the upper and lower respiratory tract including pharyngitis, bronchitis, and lobar or bronchopneumonia in the early inflammatory stages.

6. Sulfapyridine is much less effective in the peracute and chronic stages of distemper. Old, protracted cases showed less response to the bacteriostatic effects of the drug, but beneficial results were noted in most instances.

7. Sulfapyridine given in the early stages tends to prevent the complications and serious sequelæ of distemper, such as hæmorrhagic enteritis, dystentery, or chorea.

Clinical Studies of Sulfapyridine in Small Animal Practice. By J. R. Ketchersid. *J. Amer. Vet. Med. Assn.* 1940. *XCVI,* 661.

This article referred to above had the following conclusions:—

"Observations made in treating the 20 clinical cases cited would seem to indicate that sulfapyridine is highly effective in septicema diseases of dogs when given in initial daily dosage of 1 gr. per pound of body weight divided into four doses. It is recommended that this be decreased 50 per cent. each succeeding 24 hours.

"It also seems advisable to continue the use of the drug for at least 48 hours after the temperature reaches normal.

"The time required to complete treatment with sulfapyridine in most

canine patients is so short that there is little risk of kidney damage. Neither is there a great change in the blood cellular elements. It is not to be concluded that we recommend its use entirely without thought to the periodic examination of blood and urine.

"Sulfapyridine may nauseate some individuals but this can be controlled by the simultaneous administration of an equal amount of milk sugar.

"Recent observations show that the drug is of value in treating acute tonsillitis and post-parturient metritis, but the results with these cases did not surpass those recorded for similar chemotherapeutic agents."

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